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ABSTRACT

This document describes research which investigated the effectiveness of the Cities in Schools (CIS) hypermedia training course for senior executives of that national dropout prevention program. The study employed a hybrid methodology of qualitative techniques and computer tracking tools, in order to provide a complete picture of how the hypermedia training course was delivered and received. Thirteen trainees and three professional trainers participated in a week-long training course. The goals of the study included how hypermedia is used in a "real-world" setting; hypermedia characteristics for further research; how frequently and to what extent trainers and trainees used hypermedia; methods of exploring hypermedia materials; and relationships of hypermedia use, non-hypermedia activities, and attainment of learning objectives of the course. Results of the qualitative component indicate that the following areas warrant examination in future studies: diversity of trainers and grouping issues; cooperative learning; presentation, formal evaluation of learning; applying learning to real-world situations; use of supplemental trainer-developed materials and print materials; variations in trainers' styles; time management; and course evaluation. The preliminary results of the computer tracking component of the study are presented, but it was not possible to continue the analysis of the relationship between uses of hypermedia and the attainment of specific learning objectives. Preliminary analysis of hypermedia paths used by trainers indicates that the trainees often traveled extremely complex paths while using the hypermedia training materials. Implementing computer tracking tools requires considerable programming expertise and effort, and are most efficiently implemented if they are incorporated into the design of the hypermedia application as it is developed. (Contains 8 references.) (AEF)

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Title:

A Hybrid Investigation of Hypermedia Training

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Introduction

Hypermedia is a relatively new technology, and data on the most effective ways to use hypermedia in training, while steadily growing, are still relatively scattered. Hypermedia, because of its greatly expanded capabilities over traditional computer-based training, presents new challenges for designers, developers, and evaluators of training as well as trainers. Issues arise in the design, development, and delivery of hypermedia training which were not present with traditional computer-based training and therefore were not given extensive treatment either in the development of theoretical models of computer-based instructional design or in the design of such instructional materials. Examples of the additional complexities which must be addressed in designing and delivering effective hypermedia-based training include: the appropriate type and degree of structure to be incorporated into the information content of hypermedia applications; the extent and type of navigation options to be provided to the user; the appropriate role of the trainer or facilitator; and the appropriate mix of different media (text, computer graphics, computer-generated animation, still video graphics and photographs, motion video, digitized speech, other audio, etc.).

Use of Qualitative Research Methodologies

Because hypermedia training is so new and so complex, it is difficult to identify appropriate research hypotheses which can be investigated using quasi-experimental techniques. Furthermore, the complexity of hypermedia training used in trainer-facilitated group settings (the type of hypermedia training investigated in this study) makes it difficult if not impossible to control adequately for plausible rival hypotheses. For these reasons, these researchers feel that qualitative methodologies constitute a more appropriate approach for the investigation of the effectiveness of hypermedia training.

Qualitative approaches provide a broader perspective on actual applications of hypermedia training in real-world settings. This approach was chosen because the researchers recognized that, at this stage in the development of hypermedia technology, we do not have a sufficiently well-developed understanding of which variables related to the use of hypermedia are most appropriate to investigate, and how to systematically control these variables in quasi-experimental studies. Use of qualitative methodologies also represents an acknowledgment that the researcher can not, indeed may not want to, exert complete control over the training situation. In fact, attempts to impose undue control over the delivery of training may introduce distortions in the way hypermedia is used which will negatively effect the validity of the data collected. At this point in the development of our understanding of how to use hypermedia effectively for training, it seems that the most important question to be addressed is, "What is going on when hypermedia is used for training?"

Use of Computer Tracking Tools

On the other hand, quantitative data on the uses of hypermedia for training, when they can be collected unobtrusively and without artificially distorting the delivery of training, can provide the foundation for analysis which supplements the qualitative observations and contributes to their validity, or which flags results which may appear to be conflicting and which require further investigation. Of particular value is the collection of quantitative data on the extent and specific ways in which trainees use hypermedia in a specific training program. This can be accomplished through the use of computer-based tracking tools incorporated into the hypermedia application used.

Computer tracking tools can record the number and type of inputs (keyboard entry, mouse pointing or clicking, etc.) into the hypermedia program by the user at any point in the program, as well as the exact time and duration of the interaction. This information, then, provides a comprehensive record of how a specific user interacted with the hypermedia, including the paths taken by the user from screen to screen, and the type, time, and duration of the interactions.

Computer tracking tools have been used by a number of researchers for formative evaluation and for formal research on attributes of hypermedia training. Gay and Mazur (1993) described several different types of computer tracking tools, ranging from tools which produce primarily text-based lists to tools which produce graphical and/or pictorial depictions of users' actions. They described how they used these tools in the investigation of hypermedia programs developed at Cornell's Interactive Multimedia Group. Misanchuk and Schwier (1991) identified three distinct uses for computer tracking tools, the outcomes of which they referred to as audit trails. These uses included: 1) data collection for formative evaluation; 2) tools for basic research into instructional design of multimedia; 3) auditing use of multimedia in a public

forum. They describe several quantitative and qualitative methods for describing and analyzing computer-generated audit trails.

The developers of the Cities in Schools (CIS) hypermedia training curriculum recognized the potential of incorporating computer tracking tools into the CIS hypermedia software early in the project. Design specifications of the hypermedia included an analysis of the types of data to be collected and the mechanisms for collecting that data automatically (Story and Harvey, 1990).

Use of Hybrid Methodologies

This paper will describe a research effort which investigated the effectiveness of the CIS hypermedia training course for senior executives of that national dropout prevention program. The study employed a hybrid methodology of qualitative techniques and computer tracking tools, in order to provide as complete a picture as possible of how the hypermedia training course was delivered and received.

The Cities in Schools Hypermedia Training Curriculum

The authors have been involved, for the past six years, in the design, development, and implementation of an integrated hypermedia training curriculum for Cities in Schools, Inc. The CIS training curriculum was developed by faculty and staff of the Advanced Information Technologies Laboratory (AITL) in Lehigh University's College of Education.

The CIS integrated hypermedia training curriculum was developed by a team which included instructional design specialists; designers and producers of video, computer, and print training materials; and experts in adult learning. Three courses, comprising a total of ten weeks of full-day training, have been developed. The CIS training curriculum is now being delivered by CIS trainers (trained by AITL staff) at the CIS National Training Institute at Lehigh University and at six regional CIS training centers around the country.

The Cities in Schools hypermedia training curriculum uses a training paradigm different from the one-person/one computer paradigm of traditional computer-based training. Instead, a novel approach to the use of hypermedia for training is employed in which the hypermedia materials are used as training resources to facilitate interpersonal interactions in trainer-facilitated group learning activities.

The CIS training course investigated for this study was the Program Operations course, designed to train senior management personnel who are executive directors of city-wide or county-wide CIS programs. The course included a comprehensive (2500-screen) hypermedia software program, a one-hour videodisk, and trainers' and trainees' printed materials. A simulated city with a CIS dropout prevention program were incorporated into the training materials. A trainer's resource book included objectives, learning strategies, and evaluation strategies for 32 learning activities which incorporated a total of 117 separate learning sub-activities.

The CIS Program Operations course supported multiple modes of learning, including:

- presentations by the trainer;
- examination of computer, print, and/or video materials by individuals, pairs, or small groups of trainees;
- small group and large group discussions;
- role playing;
- other group activities, and
- individualized, self-paced learning activities.

Design, development and delivery of CIS hypermedia training was guided by the Advanced Information Technologies Laboratory Process Model (Harvey, 1993). According to this model, learning proceeds from lower level activities (information acquisition and comprehension) to higher level (analysis and synthesis; application in simulated settings), and culminates in a systematic application of the knowledge to a real-world situation.

Purpose of the Study

The authors recognized that, since hypermedia is a new tool for training, a comprehensive body of knowledge describing how hypermedia can best be used for training has not yet been developed. In fact, the

salient characteristics of an appropriate training program which utilizes hypermedia training have not yet been identified. The Cities in Schools hypermedia training course represented the collective knowledge and wisdom of the AITL development group. The purpose of the research study reported in this paper was to validate the approach taken in developing CIS hypermedia training, and to identify aspects of using hypermedia for training which would warrant closer examination. Specific goals of the qualitative component of this research study are presented in the following sections.

How is Hypermedia Used in a "Real-World" Setting?

Since hypermedia is a new technology, and the approach taken by the CIS hypermedia curriculum was novel, researchers wanted to determine and describe in detail how the hypermedia curriculum was used in an actual course delivered in a "real-world" setting.

What Characteristics of Hypermedia Warrant Further Research?

The purpose of the study was to describe, as much as possible, every aspect of the week-long hypermedia training program. Analysis of the data collected would serve as a foundation for identifying specific questions and hypotheses about teaching and learning with hypermedia which could be investigated in future research.

Specific goals of the computer tracking tools component of this research study are described in the following sections.

How Frequently and to What Extent Did Trainers and Trainees Utilize Hypermedia Materials?

The CIS Program Operations training course was designed as an integrated hypermedia training course. The hypermedia materials were designed to present information, provide guidance and support materials for comprehension and higher-level (analysis/synthesis and application activities) learning activities. The materials provided resources and tools for both trainer and trainee in the knowledge and skills required to function effectively as an executive director of a city-wide or county-wide Cities in Schools program. Trainer-facilitated learning activities included role-playing and small-group and large-group discussion used in conjunction with and as follow-up to interaction with the hypermedia materials. The researchers were interested in the frequency and amount of time specific groups of trainees spent actually interacting with the hypermedia materials compared to the amount of time spent in other activities away from the hypermedia workstations.

Which Paths Did Different Users Employ in Exploring the Hypermedia Materials?

Structures of hypermedia applications vary widely, from relatively sequential to totally nonsequential. The CIS hypermedia application investigated employed a hierarchical structure, in which computer, print, or video learning resources were grouped into learning sub-activities which addressed a specific learning objective. Ordinarily, trainers directed trainees to examine some or all learning resources for a specific learning sub-activity. However, resources for all of the learning activities were available at any time, and users could access them by selecting the main screen for any learning activity. In addition, user tools in the CIS hypermedia application included a "personal hypermedia list" option, which provided the capability to navigate directly to a computer resource which had been added to the user's personal list. Thus, each trainee's "path" through the hypermedia was potentially different. One purpose of this study was to examine the actual trainee use of the hypermedia in a week-long training program.

What Relationships Were Present Among the Ways Hypermedia Materials Were Used, the Extent and Type of Non-Hypermedia Activities, and the Attainment of Specific Learning Objectives of the Hypermedia Training Course?

Specific learning objectives are included for each of the 117 learning sub-activities included in the CIS Program Operations training course. For each learning objective, matching evaluation strategies are presented which specify criteria which would indicate that the learning objective had been met, and where to look for such evidence (for example, in trainees' comments during small- or large-group discussions, written statements by students made on activity sheets, or the trainees' written summary action plans).

Learning objectives and learning strategies are clearly specified in the resource book provided to each trainer. Since the overall goal of CIS Program Operations training is to help trainees develop the sum of knowledge and skills which the learning objectives represent, it was important to demonstrate that this goal had been achieved. In addition, the researchers were interested in whether any relationships emerged between the ways hypermedia was used in training and the degree to which training objectives were met. For example, would a higher proportion of trainees meet learning objectives when trainers made extensive use of the hypermedia than when trainers concentrated on other, non-hypermedia training activities?

Method

A hybrid methodology was employed in this study. The qualitative methodology employed was developed during two pilot tests, then refined for use in the study of a week-long training course. All aspects of this use of hypermedia were examined, including the demographics of the participants, trainees' and trainers' use of the hypermedia materials, their use of supplemental, trainer-developed materials, and the interactions among participants (on-task and off-task, during training sessions, and during social activities).

Subjects

Subjects for the study were the thirteen trainees and three professional trainers who participated in a week-long training course. The trainees, all of whom had volunteered for the course, varied widely in age, race, level of education, and amount of experience or knowledge of CIS operations. None of the trainees expressed noticeable computer anxiety.

Trainers for the course were Cities in Schools trainers. All three had extensive professional training experience, either with Cities in Schools or with other organizations. All had taught the course at least once previously, although their depth of experience with this particular course varied.

Qualitative Methodologies

The observer (Nelson) used non-participant observation, a method which is applied by many researchers in the social sciences (Delamont, 1992; Miles & Huberman, 1984). The observer took extensive hand-written notes while observing training. Observations were recorded in brief descriptions and were subsequently expanded upon. The handwritten notes were supplemented by audiotape recording. The notes and tapes were reviewed each evening, in order to identify patterns and unusual events which should be examined more closely on following days.

The CIS Hypermedia Computer Tracking Tools

Hypermedia tracking tools were designed into the CIS hypermedia applications, and implemented at the same time the application itself was developed. The tools, which were developed as SuperCard procedures, continually monitored the status of the hypermedia workstation. Interactions of any kind (key press, mouse click, viewing video, etc.) were recorded. Time of day was also continually monitored, and the time and duration of all activities was recorded.

Data from the computer tracking tools was automatically collected in a text file. Information collected for each trainee (or pair of trainees working together on the same hypermedia workstation) included:

- the time the computer was first turned on;
- the start time of each interaction session;
- the end time of each interaction session;
- complete information on any user input (keypresses, mouse-clicks, etc.), and the time of day of such interaction;
- the start time of each period when the computer was not being used;
- the end time of each idle period;
- summary data for each day's hypermedia computer use.

Data from the raw text files was transported into a spreadsheet, and cross-tabulations of total usage and tables of usage patterns were generated for each computer workstation. These data were then analyzed in order to identify possible patterns of use.

Results of the Qualitative Component of the Study

Documentation of training events in the form of extensive logs and other information collected during the course of the five-day training course provided a wealth of data. Analysis of these data indicated a number of topics which will warrant closer examination in future studies. These areas for further investigation were described in detail elsewhere (Nelson, 1994; Nelson and Harvey, 1994), and will be summarized here.

Diversity of the trainees and grouping issues. The wide variation in background and experience suggests that grouping trainees of similar backgrounds and experience levels should be investigated.

Cooperative learning. Trainees working in pairs appeared to exhibit more frequent and higher quality interpersonal interactions. Requiring grouping may promote cooperative learning and increase training effectiveness.

Presentation of objectives. Trainers were inconsistent in overtly presenting objectives of learning activities. Further study is needed on whether consistently and clearly presenting objectives will increase the probability of the attainment of those objectives.

Formal evaluation of learning. Trainers varied widely in the degree to which they systematically applied recommended evaluation strategies. Since many of the evaluation strategies focused on comments during group discussions, it was difficult to assess individual attainment of objectives. Methods are needed which will provide evidence of the degree to which each trainee meets training objectives, while at the same time not hindering the flow of interpersonal interactions and sharing of learning.

Applying learning to real-world situations. Activities designed to help trainees systematically apply learning from training to their own job situations (by developing a comprehensive "action plan") were implemented sporadically by trainers. Further study of trainees after they have returned to their own job situation would indicate whether the results of training are having a significant long-term effect on trainees' behavior.

Use of supplemental trainer-developed materials. On several occasions, trainers implemented training activities of their own design in lieu of the activities included in the hypermedia curriculum. The content and quality of these materials varied widely. It remains to be seen whether the Hawthorne effect potential of trainer's using materials they developed themselves will overcome the uneven quality of those materials.

Use of print materials. Although the CIS hypermedia course attempted to integrate the use of computer, video, and print materials (e.g., by including a "Print resource" icon on each computer resource screen which dictated specific pages of print manuals), trainers only occasionally directed trainees to these materials. A study in which the use of print materials is carefully controlled and monitored would validate the usefulness of print materials in the context of hypermedia training.

Variations in trainers' styles. Trainers varied in the degree of apparent comfort with and agreement with the principles of hypermedia training incorporated into the training program. A study which would pre-assess trainers' preferred instructional styles, monitor the styles actually employed, and measure the degree of trainees' attainment of objectives, could identify the trainer styles which were most effective in specific situations and, more importantly, those trainers' styles which may impede trainees' learning. Such a study would of necessity include a larger number of trainers, and may be difficult to implement, since control of variations among trainee groups would be problematic.

Time management. Trainers in this particular course appeared to have difficulties managing training time. Estimates of time needed for specific learning activities often proved inaccurate. Logistics (e.g., limiting time spent on breaks to the specified period) also impacted the training schedule. In this case, it appears that additional trainer training is warranted, rather than a formal investigation, since the deleterious effects of poorly managed training time are obvious.

Course evaluation. Trainers evaluated trainees' perceptions of the hypermedia training course by daily "process check" open discussions and by a Likert-type reaction form on the final day of training. Each of these methods have significant shortcomings. More valid and more reliable course evaluation methods need to be developed and tested in future studies of hypermedia training.

Results of the Computer Tracking Component of the Study

The computer tracking component of this study was more exploratory in nature than the qualitative component. The computer tracking tools produced a voluminous amount of raw data. Because of the vast amount of data, data reduction and subsequent analysis have proceeded at a slower pace than originally expected. Preliminary results of those parts of data analysis which have been completed to date are presented in the following section. The completed results, when they have been compiled, will be reported in a future paper. Data are simply reported here. No conclusions are drawn from them.

Frequency and extent of use of hypermedia materials. Table 1 presents the amount of time trainees at each of six hypermedia workstations spent actually interacting with the hypermedia training materials and the total training time. The amount of time trainees spent actually interacting with the hypermedia materials was surprisingly low, ranging from no time spent using hypermedia software by one trainee on one day to a high of 20%. The overall mean usage time for all trainees over the first four days of training was 8%.

Table 1
Amount of Time Hypermedia Computers Were Used
as Percentage of Total Training Time

Trainee No.	Day 1	Day 2	Day 3	Day 4	Mean	Std. Dev.
1	9%	18%	3%	6%	9%	7%
4	17%	10%	12%	4%	11%	5%
5 & 10	12%	6%	10%	4%	8%	4%
6&9	20%	9%	9%	4%	11%	7%
8	16%	2%	7%	3%	7%	6%
11	11%	0%	6%	3%	5%	5%

Note 1. Day five of training was a half-day session devoted to trainees' presentation of action plans and course evaluation. Only one trainee used the hypermedia on day 5 for eight minutes. Therefore, analysis of day 5 usage was dropped.

Note 2. Overall mean = 8%; S.D. = 6%.

Table 2 presents the beginning and ending times of interactions with the hypermedia engaged in by trainees during the first four days of training. This table presents, in tabular form, a picture of the usage patterns of trainees.

Table 2
Usage Patterns of Hypermedia Computers During Training

Trainee	Day.	Start 1	End 1	Start 2	End 2	Start 3	End 3	Start 4	End 4	Start 5	End 5
1	1	11:07	11:41	12:46	12:53	1:05	1:12				
	2	10:20	10:57	4:07	4:18	4:51	4:56	5:30	5:43	5:56	5:58
	3	9:50	9:59	10:11	10:12	11:03	11:04				
	4	9:40	9:41	10:50	11:11						
4	1	11:05	11:44	2:43	3:09	4:47	4:58	5:09	5:11	5:46	5:56
	2	10:24	10:53	1:33	1:35						
	3	11:53	12:06	12:12	12:47						
	4	10:53	11:12	12:41							
5&10	1	10:59	11:34	2:34	2:58						
	2	10:12	10:33								
	3	10:15	10:22	10:36	10:37	12:01	12:35				
	4	10:44	11:03								
6&9	1	11:04	11:41	12:18	12:38	2:40	3:06				
	2	10:19	10:55								
	3	12:09	12:45								
	4	10:50	11:09								
8	1	11:01	11:34	2:34	3:00	4:38	4:54				
	2	1:39	1:53								
	3	9:33	9:34	12:03	12:33						
	4	10:49	11:04								
11	1	10:58	10:59	2:40	2:54	4:39	4:54	5:39	6:03		
	2										
	3	12:05	12:11	12:29	12:34						
	4	10:43	10:54	11:15	11:16						

Relationships among use of hypermedia, use of non-hypermedia activities, and attainment of specific learning objectives. Unfortunately, this portion of the study turned out to be the least effective of the entire study. The major problem which hindered collection of comprehensive and valid data relative to the attainment of learning objectives was that the trainers varied widely in the degree to which they attended to the learning objectives specified in the trainer's resource book for each learning activity, and the extent to which they carried out systematic application of the suggested evaluation strategies. On some occasions, trainers presented the learning objective for a learning activity they were facilitating, and reminded trainees that the they could remind themselves of the learning objective by clicking on the "Objectives" icon which was always present on the computer's screen. Other trainers did not present the objective explicitly, and in some cases their behavior indicated that they had not understood or were not aware of the learning objective. Applications of the evaluation strategies was sporadic at best. For these reasons, it was not possible to continue the analysis of the relationship between uses of hypermedia and the attainment of specific learning objectives.

Analysis of hypermedia paths used by trainees. Data on the type of hypermedia paths used by various trainees are in the process of being analyzed. Preliminary analysis of the data indicates that trainees often traveled extremely complex paths while using the hypermedia training materials. Categorization of these paths has proven difficult and time-consuming. A number of tools are under development to facilitate categorization of hypermedia paths. These tools, and the results of their application, will be described in a future paper.

Discussion

The volume of information collected through the qualitative component of the study proved challenging to summarize and comprehend. The results of the data analysis process, however, met the goals of the research study, in that a clear and comprehensive picture of what happened during a five-day hypermedia training program was developed. The comprehensive picture provided a foundation for identifying a number of important questions which are appropriate for follow-up study. Several of these questions can be expressed as null hypotheses which can be investigated by applying quasi-experimental techniques. The qualitative research has provided the context and laid the groundwork for more purely quantitative research.

Although the qualitative data had indicated that trainees spent relatively little time actually interacting with the hypermedia software, the picture of usage provided by the computer tracking data was surprisingly low. An overall mean usage time for all trainees over the first four days of training of 8% could indicate that trainers were not encouraging trainees to make appropriate use of the hypermedia. Qualitative data indicated that, in several instances, trainers presented content identical to that included in the hypermedia using overheads, flip charts, and lecture. On the other hand, it should be kept in mind that the hypermedia training materials studied were designed as integrated hypermedia to be used to support interpersonal interactions (role playing, small and large group discussions, etc.) which clarified and extended the information presented in the hypermedia. Follow-up activities of this type, whether appropriate or inappropriate, would not show up in the tracking data as time spent using the hypermedia, even though the activities clearly were extensions of the learning begun through interaction with the hypermedia materials.

Analysis of data generated by the computer tracking component of the study proved more challenging. The body of information is extremely large and extremely complex, particularly in regards to the depth and variety of hypermedia paths traversed by users. The flexibility provided by hypermedia materials clearly has both positive and negative aspects. In order to identify these aspects, and to optimize the use of hypermedia materials, it is necessary first to develop a taxonomy of types of paths which are used by different trainees. The relationships among types of paths, learning styles, and learning outcomes can then be investigated more systematically. One promising approach to developing such a taxonomy would be to examine the techniques developed by social scientists to categorize and analyze interactions in small groups.

The inability to formally examine the relationships among uses of hypermedia, uses of other non-hypermedia training activities, and the attainment of specified learning objectives was disappointing to the researchers. The researchers were also key members of the team which had designed and developed the hypermedia training course, and had worked diligently to develop meaningful objectives and appropriate evaluation strategies for these objectives. In addition, the researchers were keenly aware of the importance placed on achieving specific learning objectives by the Cities in Schools administrators who coordinated the CIS hypermedia development project. Cities in Schools had invested considerable resources in the hypermedia training curriculum, and it was important to demonstrate that these resources had been invested wisely.

Conclusions

This qualitative study of a hypermedia training program treated a particular group of trainees and trainers engaged in a particular training program as a "culture" to be investigated through intensive and careful observation. The data gathered, as in most qualitative studies, is voluminous, and requires extensive and careful analysis in order to extract useful patterns and to draw meaningful conclusions. Since each group of trainees and trainers and each training program application is different, it is not appropriate to extrapolate the results of this study to all training programs using hypermedia application.

Qualitative studies are, however, extremely useful for providing a comprehensive picture of what actually happens in a "real-world" training situation. This picture provides a solid foundation on which to develop questions for further study, which can then be investigated systematically using quasi-experimental methodologies.

Computer tracking tools, to be implemented, require considerable programming expertise and effort. In addition, they are most efficiently implemented if they are incorporated into the design of the hypermedia application and implemented as the hypermedia application itself is developed. Difficulties inherent in allocating scarce project resources to develop tracking tools, including the challenge of incorporating tracking tools while meeting pressing delivery due dates, makes it difficult to implement tracking tools on a wide basis. In addition, it is extremely difficult to add tracking tools on a post hoc basis, especially by people other than the group who originally designed and developed the hypermedia application. For these reasons, tracking tools have not, to date, been used extensively in hypermedia research.

These researchers believe that computer tracking tools hold great promise for providing insights into how hypermedia applications are actually used and how they can be used more effectively. These tools are particularly effective when their use is combined with other research methodologies, such as qualitative investigations of specific hypermedia training courses. Both qualitative research methodologies and computer tracking methodologies hold great promise for furthering understanding of how hypermedia can be designed for effective training. Both have the advantage of being applied in "real-world" settings, studying actual applications of hypermedia as they are actually being used without distorting that application by their presence. When used in combination, qualitative research methodologies and computer tracking methodologies provide a synergistic extension of the information provided by each, and therefore provide a comprehensive and powerful foundation on which to base future decisions about the design and delivery of hypermedia-based training.

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